SYLLABUS OF PRE-Ph.D. ENTRANCE TEST (S.R.T.M.U.Nanded)

SUB:- MATHEMATICS

Unit I. Real Analysis and Complex Analysis: Elementary set theory, Finite , Countable and Uncountable Sets, Real number system, Sequences and Series, Continuity, Uniform continuity, Differentiability, Mean value theorems, Riemann integration (Definition and simple properties), Metric spaces(Definition and examples), Algebra of complex numbers, Analytic functions, Cauchy's theorem and integral formula.

Unit II. Algebra: Groups, Subgroups, Normal subgroups, Quotient groups, Cyclic groups, Permutation groups, Rings (Commutative ring, Division ring), Field (definition and examples), Ideals (Principal ideal, Prime Ideal, Maximal Ideal), Integral domain.

Unit III. Linear Algebra: Vector spaces, Linear dependence and independence, Basis, Linear transformations, Algebra of matrices, Rank of a matrix, Determinant, Linear equations, Eigen values and Eigen vectors.

Unit IV. Number Theory: Divisibility, Linear Diophantine Equation, Congruences, Arithmetic functions.

Unit V. Differential equation: Ordinary Differential Equation, Order and Degree of ODE, First order ODE, Exact differential equations, Homogeneous and Non-homogeneous ODE, Linear and Nonlinear ODE, Equations with constant coefficients and variable coefficients, Partial Differential Equation, Derivation of PDE, Complete, Particular, Singular and General Integrals of PDE, Lagrange's and Charpit's method for solving first order PDE.

Unit VI. Integral Transforms: Laplace transform, Laplace transformation of elementary functions, Inverse Laplace transform, Convolution theorem, Fourier transform (Sine and Cosine transform).

Unit VII. Geometry: Standard equations and elementary properties of Line, Circle, Parabola, Ellipse, Hyperbola, Plane, Sphere, Cone and Cylinder.

Unit 1. Real Analysis: Riemann integrable functions, Improper Integrals, Convergence and Uniform convergence of integrals, Euclidean space R^n, Bolzano-Weierstrass's theorem, Compact subsets of R^n, Heine-Borel theorem, Line and Surface integrals, Green's theorem, Stokes theorem.

Unit 2. Complex Analysis: Cauchy's theorem for convex regions, Power series representation of analytic functions, Liouville's theorem, Fundamental theorem of Algebra, Poles and Residues, Bilinear transformations.

Unit 3. Abstract Algebra: Cayley's theorem, Symmetric group, Alternating groups, Simple groups, Rings, Maximal Ideals, Prime Ideals, Integral domain, Euclidean domain, Principal ideal domain, Unique factorization domain, Field extensions. Kernel and range of homomorphism,

Unit 4. Linear algebra: Matrix representation of linear transformations, Change of bases, Linear functional, Dual spaces, Projection, Jordan canonical form.

Unit 5. Topology: Elements of topological spaces, Continuity, Convergence, Homeomorphism, Compactness, Connectedness, Separation and Countability axioms.

Unit 6. Functional Analysis: Elements of metric spaces, Elements of Banach spaces, Hahn-Banach theorem, Open mapping theorem, Closed graph theorem, Principle of uniform boundedness, Boundedness and continuity of linear transformations, Inner product spaces(Hilbert space), Bounded operators and adjoint operator on a Hibert space, Normal, Unitary and Self-adjoint operators, Riesz representation theorem.

Unit 7. Ordinary Differential Equations: Existence and Uniqueness of solutions of $dy/dx = f(x, y)$, Green's function, Sturm-Liouville BVP, Cauchy's problem and characteristics,

Unit 8. Partial Differential Equations: Classification of second order PDE, Separation of variables for Heat equation, Wave equation and Laplace equation.

Unit 9. Mechanics: Generalized co-ordinates, Lagrange's equation, Hamiltonian canonical equation, Euler-Lagrange's equations, Variational principle, Two dimensional motions of rigid body, Motion of rigid body about an axis, Motion about revolving axis.

Unit 10. Numerical Analysis: Finite differences, Interpolation, Numerical solutions of algebraic equation, Newton-Raphson method, Gauss elimination method, Matrix inversion method, Numerical differentiation and integration. Numerical solutions of ODE, Picard's and Euler's methods.